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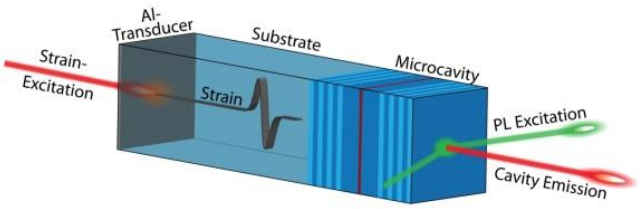
Lasing from optomechanical nanoresonators

The existence of both optical and nanomechanical resonances in the same laser microcavity results in strong photon-phonon interaction, and may be explored for the ultrafast control of vertical lasers. In the talk the experiments involving the injection of picosecond strain pulses into optically and electrically pumped vertical lasers, and monitoring of the modulated output laser intensity will be discussed. The results of three recent experiments will be presented:

- In the experiments with an ***optically pumped quantum dot laser***, an increase of the lasing output induced by strain pulses by two orders of magnitude has been observed on a picosecond time scale [1]. Such strong and ultrafast increase is due to the inhomogeneous quantum dot ensemble with a spectral broadening much larger than the optical cavity mode width. Thus, the optical resonance required for lasing is achieved for a tiny dot fraction only while non-resonant dots store optical excitation for long time. The strain pulse brings "non-resonant" quantum dots into the resonance with the cavity mode and the stored energy releases almost simultaneously in a form of the intense laser pulses.
- Experiments with ***electrically pumped micropillar lasers*** show the modulation of the emission wavelength on the frequencies equal to the resonant GHz nanomechanical modes of the micropillar. It is interesting that the micropillars with the same parameters possess various nanomechanical properties that could be due to different environment of each particular micropillar.
- Experiments with a ***quantum well vertical laser*** showed intensity modulation with the mechanical resonance frequencies (20-40 GHz) of the optomechanical nanoresonator [2].

The series of performed experiments show that coherent phonons and nanomechanical properties of the laser nanostructures have a strong effect on the laser output. Prospective application for nanophotonics and nanophononics are discussed.



References:

[1] C. Brüggemann, A. V. Akimov, A. V. Scherbakov, M. Bombeck, C. Schneider, S. Hofling, A. Forchel, D. R. Yakovlev and M. Bayer, “Laser mode feeding by shaking quantum dots in a planar microcavity”, Nature Photonics, 6, 30 (2012).

[2] T. Czerniuk, C. Brüggemann, J. Tepper, S. Brodbeck, C. Schneider, M. Kamp, S. Höfling, B. A. Glavin, D. R. Yakovlev, A. V. Akimov, and M. Bayer, "Lasing from active optomechanical resonators", Nature Communications, accepted, in press, (2014).